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September 4, 2012

Ed Randolph  
California Public Utilities Commission  
Energy Division Director  
505 Van Ness Avenue  
San Francisco, CA 94102

Re: Seismic Research Projects for San Onofre Nuclear Generating Station (SONGS)

Dear Mr. Randolph:

In accordance with Decision (D.) 12-05-004, Southern California Edison Company (SCE) respectfully submits for your review and comments the following SONGS seismic research project plans:

- 2D Shallow Marine Seismic Reflection Survey
- 3D Shallow Marine Seismic Reflection Survey
- Seafloor Surveys
- Seafloor Sediment Sampling and Age Dating
- Existing Onshore and Offshore USGS Data
- Seismic Monitoring

Included is a revised Introduction with an updated "Table 1 – Seismic Research Projects Summary" and a revised "Acronyms List." This concludes the submittal of the Seismic Research Project plans.

Should you have any questions regarding this submittal, please feel free to contact me at 949-368-3540.

Sincerely,



Caroline McAndrews  
Director, Nuclear Strategic Projects  
San Onofre Nuclear Generating Station  
Southern California Edison

This document outlines Southern California Edison's (SCE) plans for performing the San Onofre Nuclear Generating Station (SONGS) Seismic Research Projects (i.e., geological, geodetic, and geophysical surveys). SCE developed these plans with the assistance of various agencies, academia, and consultants. The seismic research projects will provide new geologic and seismic information relevant to SONGS' tectonic and seismic setting.<sup>1</sup> This information will be obtained by conducting specific research that updates existing seismic source data.

The seismic research projects have been designed to capture the most relevant seismic source data, both in space and time, for the Newport-Inglewood/Rose Canyon Fault (NI/RC) and the "hypothesized Oceanside Blind Thrust" (OBT) Fault.<sup>2</sup> The NI/RC Fault is the controlling fault for SONGS and additional information is desired to better understand the existence and characteristics of the OBT Fault. Specifically, these projects will identify the level of activity and history of the NI/RC and OBT faults. For example, these projects will consider specific fault locations, geometries, fault types, slip rates, recurrence intervals, and potential earthquake magnitudes. The results from the onshore and offshore projects are intended to provide additional data concerning the seismic setting surrounding SONGS.

Not all seismic research projects have yet been planned, and for those that have been, short descriptions have been developed and are presented in Table 1. For those projects that have not yet been planned, only the descriptive title of the project is presented in Table 1. A summary schedule for the seismic research projects is provided in Figure 1. (Table 1 revised 8/31/12.)

#### Project Management

SCE is managing the project and coordinating with a number of agencies, academia, and consultants to initiate and complete the seismic research projects.

#### Project Support

Each project is supported by a mix of the following agencies, academia, and consultants:

- GeoPentech
- Padre (permits)
- Lamont Doherty Earth Observatory
- GeoTrace (geophysical data processing)
- NodalSeismic (geophone data collection)
- GEOVision (onshore 3D)
- Earth Consultants International (onshore)
- SDSU (paleoseismic)
- UNAVCO (GPS)
- Scripps (seismology)

Offshore Technical Leaders include:

- Neal Driscoll, Scripps
- Peter Shearer, Scripps
- Steve Wesnousky, UNR
- Graham Kent, UNR
- Frank Vernon, Scripps

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<sup>1</sup> Seismic setting is defined as the identification of credible earthquake sources by studying past earthquake activity recorded by local surface and subsurface structures.

<sup>2</sup> The existence of the OBT Fault is unknown and further research is required.

Offshore Peer Review from, as available:

- Holly Ryan, USGS
- John Shaw, Harvard
- Mark Legg, Legg Geophysical
- Christopher Sorlien, UCSB

Onshore Technical Leaders include:

- Tom Rockwell, SDSU
- Lisa Grant Ludwig, UCI
- Frank Vernon, Scripps
- Karl Mueller, University of Colorado
- Ray Weldon, University of Oregon
- Peter Shearer, Scripps

Onshore Peer Review from, as available:

- James Dolan, USC
- Kathryn Hanson, AMEC
- Dan Ponti, USGS
- Roy Shlemon, Private Consultant



**Table 1 – Seismic Research Projects Summary**

Project #	Project	Project Description
1	Historical Marine Geophysical Data Reprocessing and Reanalysis	<p>This project will update seismic source data within the area of interest associated with the NI/RC and OBT faults by reprocessing and reanalyzing existing seismic reflection data collected by SCE, USGS, the petroleum industry, and academia.</p> <p>The data will be used to optimize the planning of future marine geophysical surveys in focused areas and depths within the area of interest associated with the NI/RC and OBT faults. The data will support the environmental permitting processes for those projects.</p>
2	2D Deep Marine Seismic Reflection Survey	<p>This project will collect and process 2D deep marine multi-channel seismic and other geophysical data for the area that encompasses the portion of the Newport-Inglewood/Rose Canyon (NI/RC) Fault relevant to the seismic setting surrounding SONGS, and its potential intersection with the OBT Fault.</p> <p>The data will be used to evaluate the location and geometry of the potential intersection of the NI/RC Fault and OBT Fault in the area offshore of SONGS, unless the contrast between the faults and the flanking bedrock does not facilitate imaging with modern marine geophysical methods.</p> <p>The portion of the deep marine geophysical data west of this potential fault intersection, or above the bedrock, will be used to define potential rupture area parameters for the NI/RC and OBT faults.</p> <p>The data will support evaluation of deep geologic stratigraphy, folding, and faulting below the ridges and basins defined by the bathymetry. The data may also establish the seismic velocity parameters in the underlying geologic materials, which support interpretation of the resulting marine geophysical data and establish locations and depths of offshore earthquakes.</p>
3	GPS Monitoring	<p>This project will install and monitor continuous GPS stations in the region surrounding SONGS to observe crustal deformation patterns and regional strain accumulation.</p> <p>The data will be used to evaluate slip rates and activity of the NI/RC and OBT faults.</p>

**Table 1 – Seismic Research Projects Summary (Continued)**

Project #	Project	Project Description
4	3D Deep Marine Seismic Reflection Survey	This project will collect and process 3D deep data across the intersection of the NI/RC and OBT faults similar to the <i>2D Deep Marine Seismic Reflection Survey</i> project.
5	2D Shallow Marine Seismic Reflection Survey	This project will collect and process 2D shallow data to image the geometry of the NI/RC Fault and shallow deformational features associated with the OBT Fault.
6	3D Shallow Marine Seismic Reflection Survey	This project will collect and process 3D shallow data to image the geometry of the NI/RC Fault and shallow deformational features associated with the OBT Fault.
7	Seafloor Surveys	This project will collect and process bathymetry, gravity, and magnetic data to image the geometry of the NI/RC and OBT faults.
8	Sea Floor Sediment Sampling and Age Dating	This project will collect organic and sediment samples using gravity, piston, and vibracores to determine sediment age and composition.
9	Existing Onshore and Offshore USGS Data	This project will obtain recent onshore and offshore USGS geophysical surveys to update the SONGS seismic database.
10	Marine Terrace and Coastal Deformation Investigations	This project will collect and process marine terrace data related to the vertical deformation along the southern Orange County and northern San Diego County coastline and the amount of vertical deformation contributed by the NI/RC Fault and the OBT Fault.
11	Paleoseismic Trenching	This project will excavate trenches across the Rose Canyon segment of the NI/RC Fault in San Diego County to measure fault displacement and establish fault history directly from the fault zone.

Seismic Research Projects  
Introduction (Revised 8/31/12)

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Project #	Project	Project Description
12	Seismic Monitoring	This project will install and maintain permanent onshore seismographs near SONGS and install and maintain temporary ocean bottom seismometers offshore SONGS for a three year period.



Figure 1 – Schedule of Activities

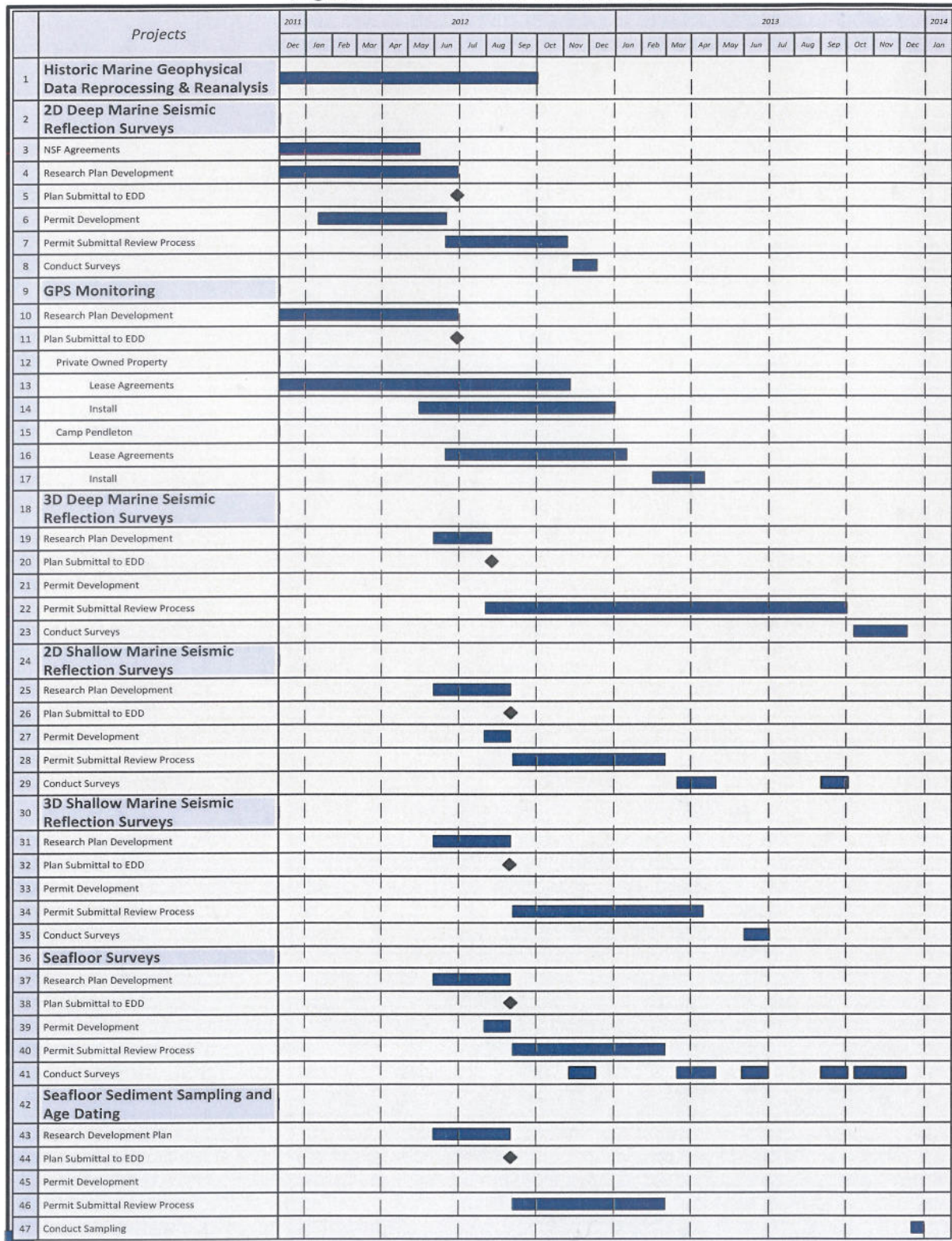
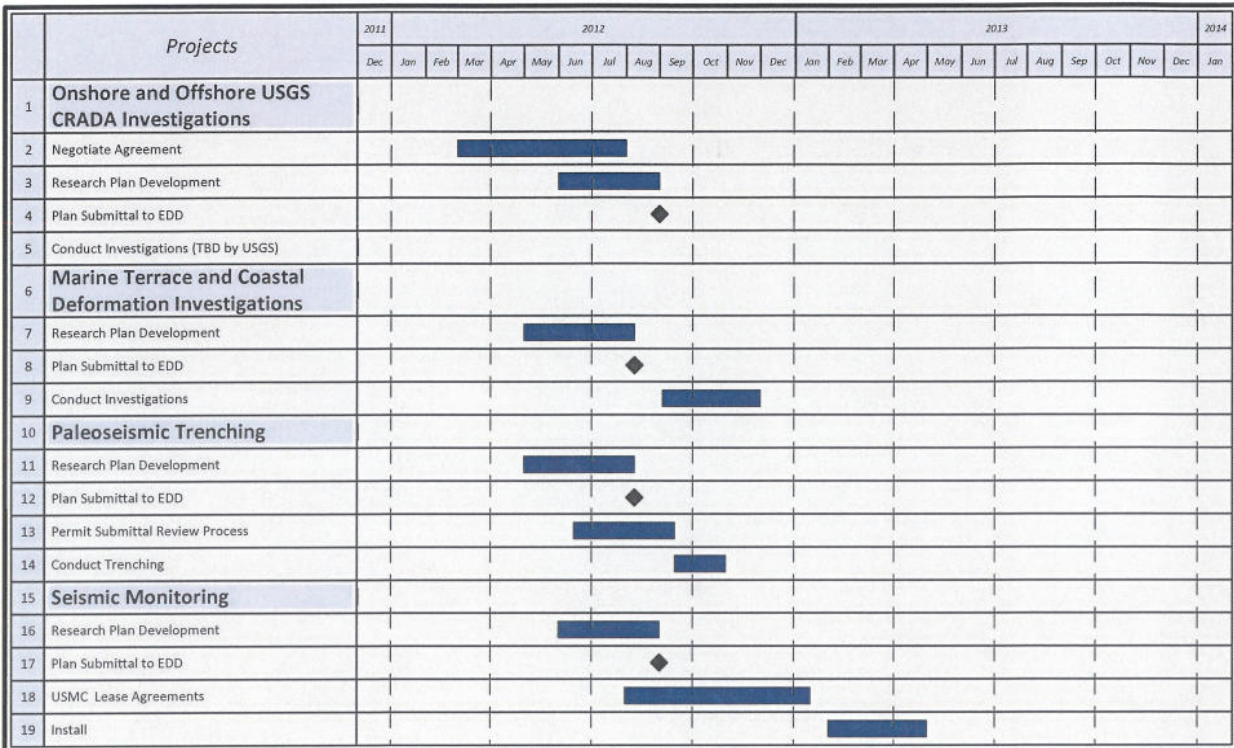


Figure 1 – Schedule of Activities (Continued)





## Objective

Collect and process 2D shallow data to image the geometry of the Newport Inglewood/Rose Canyon (NI/RC) Fault and shallow deformational features associated with the Oceanside Blind Thrust<sup>1</sup> (OBT) Fault.

## Scope of Work

This project<sup>2</sup> includes the following activities:

1. Determine the target area.
2. Obtain necessary permits to conduct the 2D shallow survey.
3. Collect and process 2D shallow data.
4. Determine the location and size of the 3D shallow survey.

### 1. Determine the target area

The target area for the 2D shallow survey will be based on data obtained from completed 2D deep data (see *2D Deep Marine Seismic Reflection Survey* project) and existing 2D shallow seismic data. The Offshore Technical Leaders<sup>3</sup> will review the location, size, and line-density for the proposed 2D shallow survey. The survey will be conducted in both federal and state waters. An example of the size of the area is shown in Figure 1.

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<sup>1</sup> The existence of the OBT Fault is unknown and further research is required.

<sup>2</sup> A.11-04-006, Shallow Marine Surveys – 2D/3D Shallow Geophysical Seismic Reflection Surveys.

<sup>3</sup> Offshore Technical Leaders are identified in the Introduction.

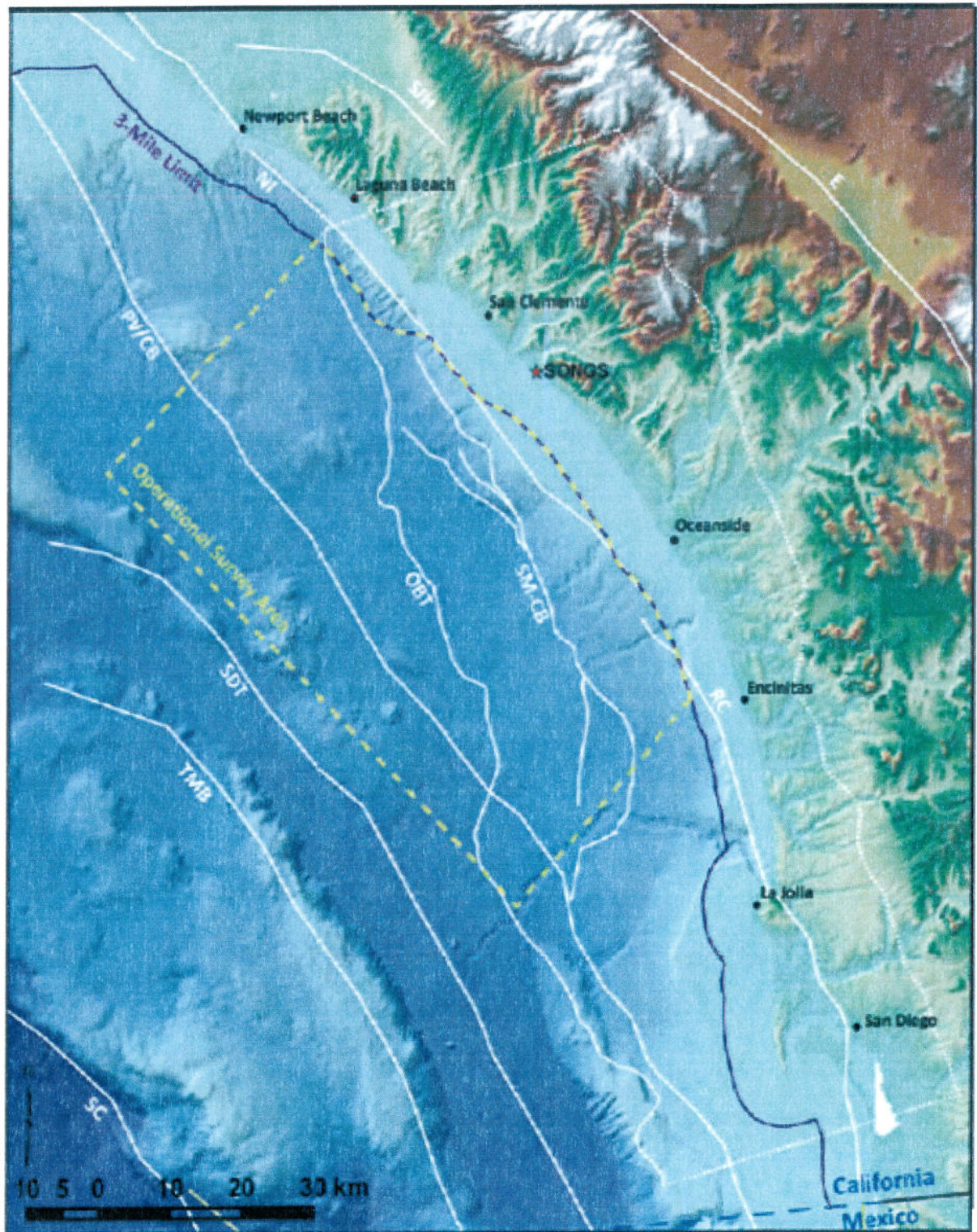


Figure 1. The 2D shallow survey will be conducted in the operational area shown for the 2D deep survey but will also extend into California state waters.



## Seismic Research Projects

### 2D Shallow Marine Seismic Reflection Survey

Figure 2 shows potential targets for the shallow survey across the NI/RC and OBT faults. One of the goals of this survey is to image how the shallow surficial deformation is related (or not) to the deep-seated fault structures imaged in the 2D and 3D deep surveys.

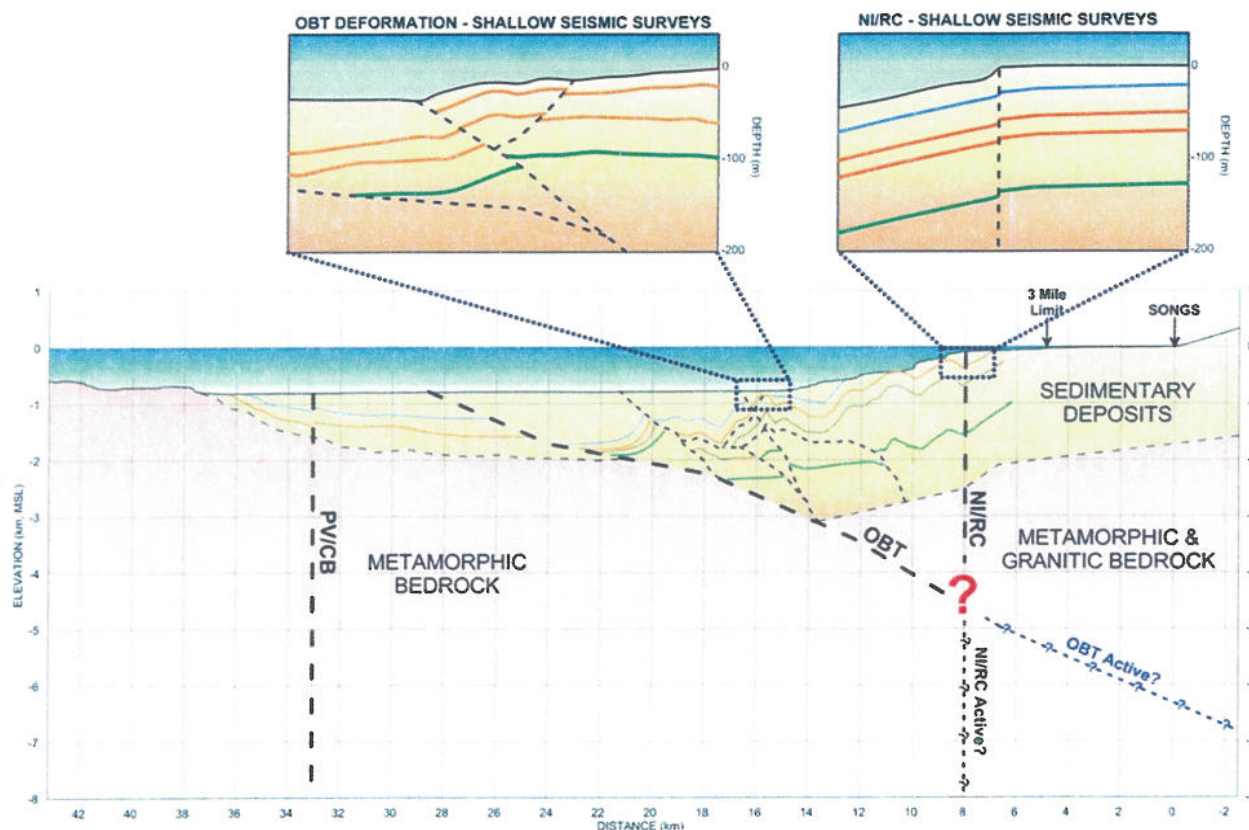


Figure 2. Schematic of shallow seismic imaging and generalized profile of offshore geologic structure.

#### 2. Obtain 2D shallow survey permits

The following permits will be secured:

- A California State Lands Commission (CSLC) permit is required as part of the California Environmental Quality Act (CEQA) process.
- An Incidental Harassment Authorization (IHA) by the National Marine Fisheries Service (NMFS) will be required due to the potential impacts to marine species. Approval of an IHA is required for compliance with the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA).
- Review of the federal permits by the California Coastal Commission (CCC) will be required under the Coastal Zone Management Act (CZMA).
- A Coastal Development Permit (CDP), issued by CCC, is required to work within state waters.



3. Collect 2D shallow data and perform QA/QC

High-resolution regional data are required to image the surficial deformation associated with the NI/RC and OBT fault systems. This project will build on and complement the 2D and 3D deep surveys and focus the 3D shallow survey. This sequenced approach is used to minimize time in the marine environment and maximize return from the acquired data. These projects will be performed in concert with seafloor bathymetric surveys described in the *Seafloor Survey* project.

Scripps and University of Nevada, Reno (UNR) personnel will be involved in the 2D shallow survey design and data QA/QC will be performed in real time on the vessel. Following the cruise, the 2D seismic data will be processed by Scripps and UNR.

4. Determine the location and size of the 3D shallow survey

Based on the 2D shallow data, the size and location of target areas for the 3D survey will be identified – specifically shallow deformational features across the NI/RC and OBT faults.

**Prerequisites**

- Required permits, stated above, must be secured.
- *R/V Melville* (or other Scripps vessel) must be available.

**Project Risks with Mitigation Plans**

- Due to weather or other unforeseen events, the shallow seismic surveys may not be completed. Mitigation: Perform survey at another time.
- The *R/V Melville* (or similar industry vessel) may not be available. Mitigation: Another Scripps vessel will be used (e.g., *R/V New Horizon*, or *R/V Sproul*).
- State environmental permits may be delayed. Mitigation: The survey schedule may need to be delayed or the 2D shallow survey will be performed with a smaller seismic source (< 2 kJ).
- Shallow data may not image geologic targets. Mitigation: Use different sound source and recording instruments.

**Specific Deliverable**

- Digital raw and processed 2D shallow data will be made publically available and will be archived at Scripps/UNR.

## Objective

Collect and process 3D shallow data to define the geometry of the Newport Inglewood/Rose Canyon (NI/RC) Fault and shallow deformational features associated with the Oceanside Blind Thrust<sup>1</sup> (OBT) Fault.

## Scope of Work

This project<sup>2</sup> includes the following activities:

1. Determine the target area.
2. Obtain necessary permits to conduct 3D shallow survey.
3. Collect 3D shallow data and perform quality assurance/quality control (QA/QC) in real time on the vessel.
4. Process the 3D shallow data.

### 1. Determine the target area

The target area for the 3D shallow survey will be based on the results of the new 2D shallow data.

### 2. Obtain 3D shallow survey permits

The time needed to obtain state water permits requires the use of existing information to define the survey target area. An example of the size of the area is shown in Figure 1. The following permits will be secured:

- A California State Lands Commission (CSLC) permit is required as part of the California Environmental Quality Act (CEQA) process.
- An Incidental Harassment Authorization (IHA) by the National Marine Fisheries Service (NMFS) will be required due to the potential impacts to marine species. Approval of an IHA is required for compliance with the Endangered Species Act (ESA) and the Marine Mammal Protection Act (MMPA).
- Review of the federal permits by the California Coastal Commission (CCC) will be required under the Coastal Zone Management Act (CZMA).
- A Coastal Development Permit (CDP), issued by CCC, is required to work within state waters.

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<sup>1</sup> The existence of the OBT Fault is unknown and further research is required.

<sup>2</sup> A.11-04-006, Shallow Marine Surveys – 2D/3D Shallow Geophysical Seismic Reflection Surveys.



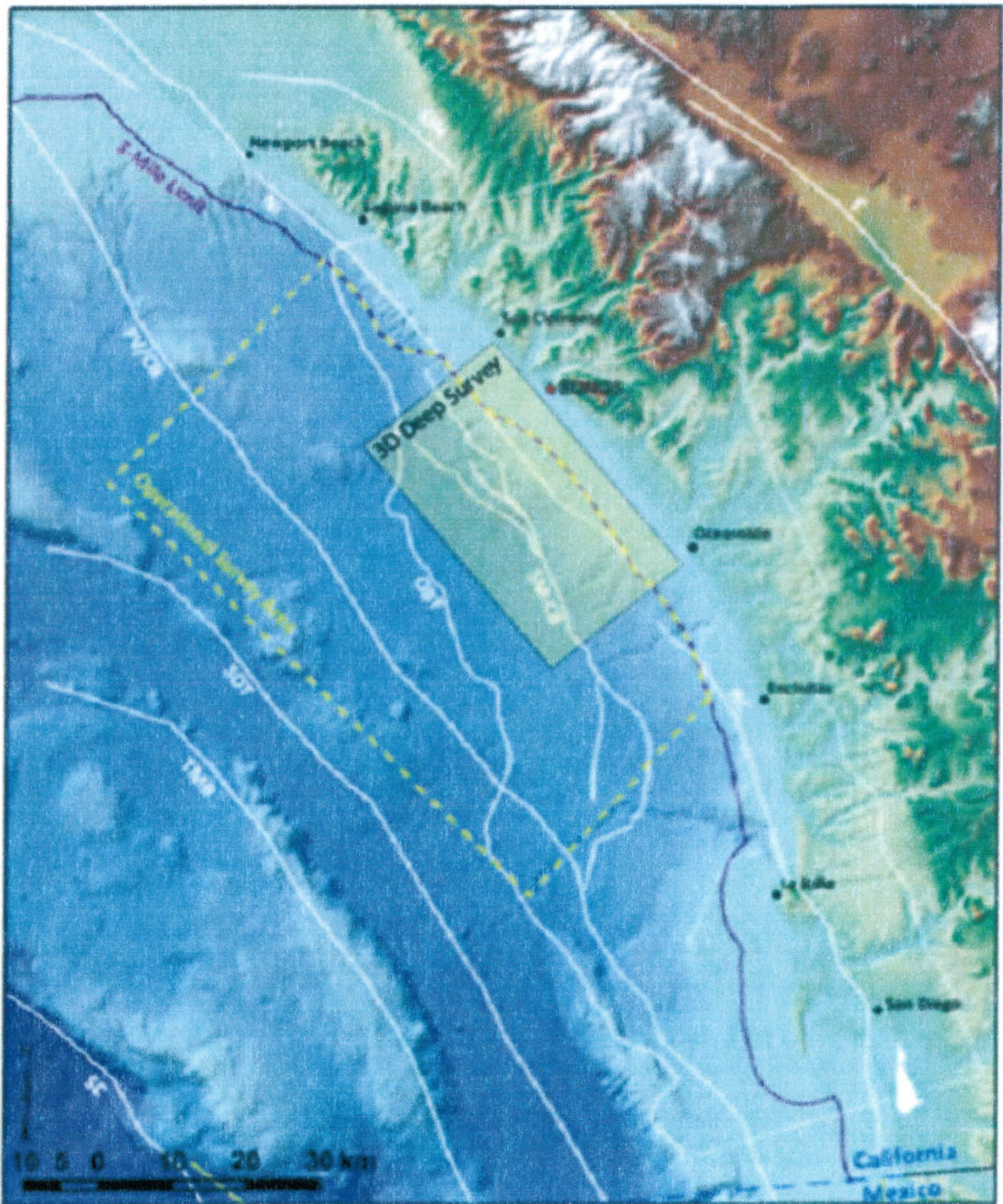


Figure 1. The 3D shallow survey will be conducted in the operational area shown for the 3D deep survey but will also extend into California state waters.



3. Collect 3D shallow data and perform QA/QC

The 3D shallow survey will be performed in federal and state waters using the *R/V Melville* vessel. The 3D shallow survey will use the P-Cable system (Figure 2) to collect data. The P-Cable system has been developed to enable 3D high resolution imaging of shallow horizons and uses a large number of short streamer sections towed parallel from the cross cable. The *RV Melville* will tow a series of approximately 14 to 18 hydrophone streamers.

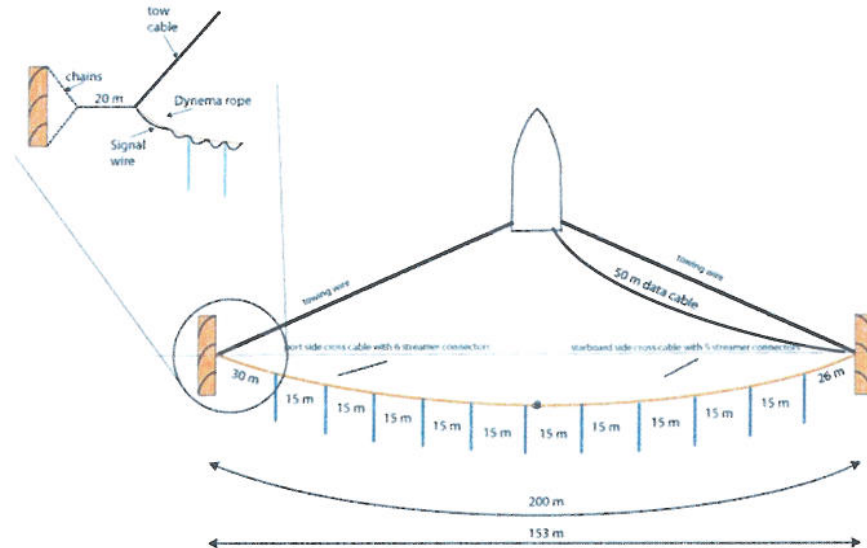


Figure 2. Schematic drawing of the basic P-Cable components during operation.

Scripps and GeoTrace (an industry geophysical processing company based in Houston, TX) personnel will be involved in the 3D shallow survey design and will participate on the survey cruise to ensure data QA/QC and that the proposed targets will be imaged properly. The 3D data will identify potential coring targets to recover material for age dating. Age dating is required to determine the fault history for the NI/RC and OBT faults.

4. Process data

The raw data will be processed by GeoTrace with oversight from Scripps and the University of Nevada, Reno (UNR).

**Prerequisite**

- Required permits, stated above, must be secured.
- *R/V Melville* (or another Scripps vessel) must be available.

### **Project Risks with Mitigation Plans**

- State environmental permits may be delayed. Mitigation: The survey schedule may need to be delayed or the 3D shallow survey will be performed with a smaller seismic source (<2 kJ).
- Shallow data may not image geologic targets for follow-on analysis and seafloor sampling; if so, slip rate/recurrence interval estimates will be less certain. Mitigation: Evaluation of fault parameters will be more reliant on the onshore investigations (i.e., marine terrace studies and Paleoseismic trenching).
- Due to weather or other unforeseen events, the shallow seismic surveys may not be completed. Mitigation: Perform surveys at another time.
- The *R/V Melville* may not be available. Mitigation: Another Scripps vessel will be used (e.g., *R/V New Horizon*).

### **Specific Deliverable**

- Digital raw and processed 3D shallow data will be made publicly available and will be archived at Scripps/UNR.

## Objective

Collect and process bathymetry, gravity, and magnetic data to image the geometry of the Newport Inglewood/Rose Canyon (NI/RC) Fault and Oceanside Blind Thrust<sup>1</sup> (OBT) Fault.

## Scope of Work

This project<sup>2</sup> includes the following activities:

1. Determine study target area.
2. Collect and process seafloor data

### 1. Determine study target area

The seafloor survey area of interest is within the area defined for the seismic reflection surveys, as shown in Figure 1. As part of the *California Coastal and Marine Mapping Initiative*, high resolution bathymetry data was collected from the beach to three miles offshore. This publicly available data will be reviewed and the gaps in the data will serve to identify the target area for this project.

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<sup>1</sup> The existence of the OBT Fault is unknown and further research is required.

<sup>2</sup> A.11-04-006, Shallow Marine Surveys – High Resolution Bathymetry Surveys.



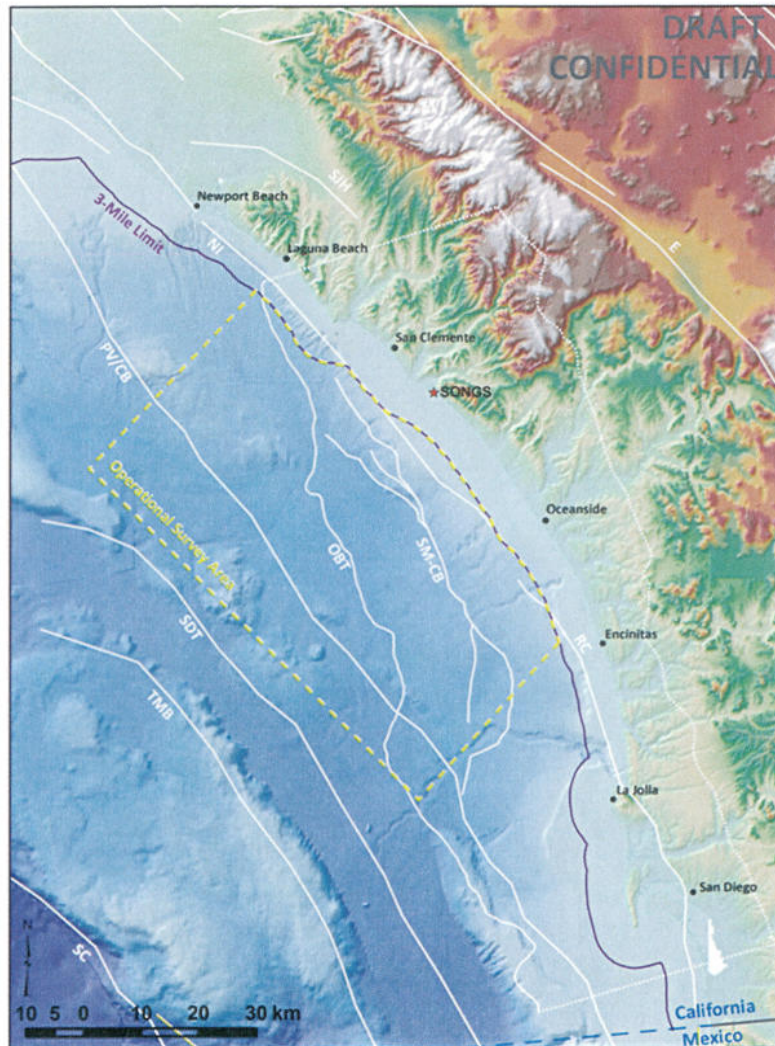


Figure 1. 2D/3D seismic reflection survey area is shown by the yellow dotted line.

2. Collect and process seafloor data

The seafloor surveys include collection of high resolution bathymetry, gravity, and magnetic data. The seafloor surveys will be performed at the same time as the deep and shallow seismic surveys. A schematic of the profiling operations are shown in Figure 2.

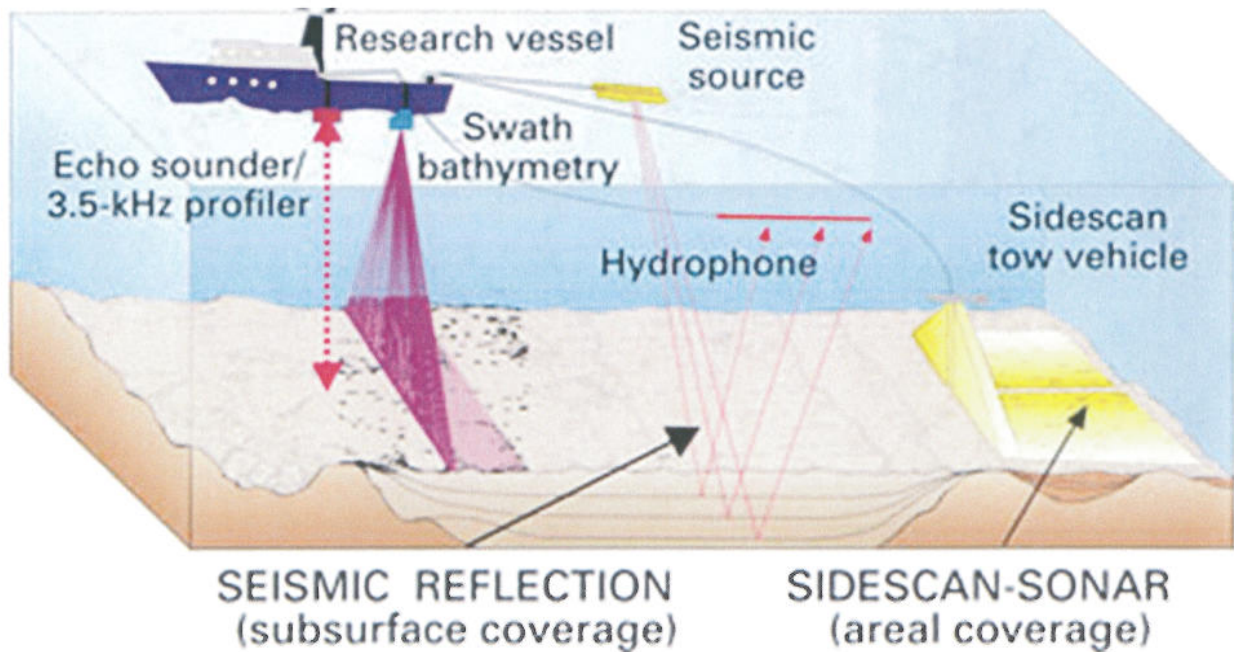


Figure 2. Schematic showing data collection at sea.

High resolution bathymetry surveys determine seafloor relief. In addition to bathymetry data, the system collects back-scatter images from the seafloor. The processed data maps the seafloor relief, such as ledges, linear gulley, and undisturbed seafloor. The high resolution bathymetry and back-scatter data will identify targets for follow-on seafloor sampling.

Gravity methods measure variations in the earth's gravitation field caused by the differences in the density of subsurface rocks, and magnetic surveys measure variations in the earth's magnetic field and record variations in the distribution and type of magnetic minerals in subsurface rocks. Seismic reflection data is integrated with gravity and magnetic data to provide more information about the subsurface geology.

Scripps and University of Nevada in Reno (UNR) will process the bathymetry (water depth in meters), gravity (force in mgal), and magnetic (force in nanotelsa) data.

**Prerequisite**

- 2D and 3D seismic surveys must occur.

**Project Risk with Mitigation Plan**

- 2D and 3D seismic reflection surveys are not conducted, either due to permits or weather. Mitigation: Seafloor surveys will not be conducted as stand-alone expeditions.

**Specific Deliverable**

- Digital raw and processed data will be made publicly available and will be archived at Scripps/UNR and at the archives at Lamont-Doherty Earth Observatory.



## **Objective**

Collect organic and sediment samples using gravity, piston, and vibracores to aide in determining the history of the Newport Inglewood/Rose Canyon (NI/RC) and Oceanside Blind Thrust<sup>1</sup> (OBT) faults.

## **Scope of Work**

This project<sup>2</sup> includes the following activities:

- Determine the study target area.
- Obtain necessary permits to conduct seafloor sediment sampling.
- Collect sediment samples using gravity, piston, and vibracores.
- Process recovered sediment samples.

### **1. Determine the study target area**

Based on the data recovered during the 2D and 3D shallow marine seismic reflection surveys, offset sediment layers will be targeted.

### **2. Obtain necessary permits**

A California State Lands Commission Geophysical and Geological Permit is required.

### **3. Collect sediment samples**

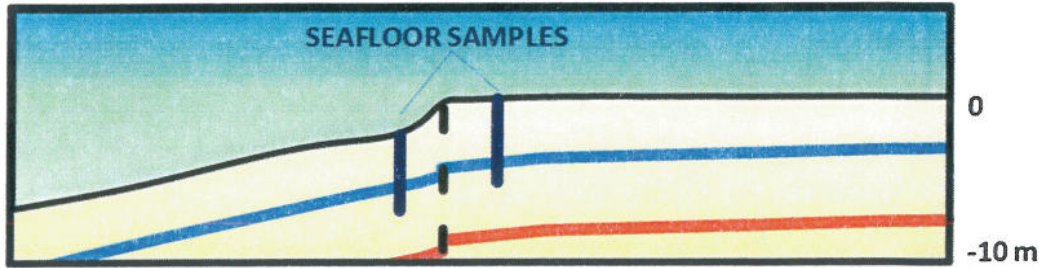
Dateable organic material and sediment samples will be collected on either side of the faults (see Figure 1) to determine the age of offset geologic layers imaged by 2D and 3D shallow marine seismic surveys. Vibracores will be used in sandy environments on the near-shore shelf. Gravity and piston cores will be used along the continental slope and rise where the sediment is predominately silts and clays.

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<sup>1</sup> The existence of the OBT Fault is unknown and further research is required.

<sup>2</sup> A.11-04-006, Shallow Marine Surveys – Seafloor Sediment Sampling and Age Dating.

## NI/RC - SHALLOW SEISMIC SURVEYS



## OBT DEFORMATION - SHALLOW SEISMIC SURVEYS

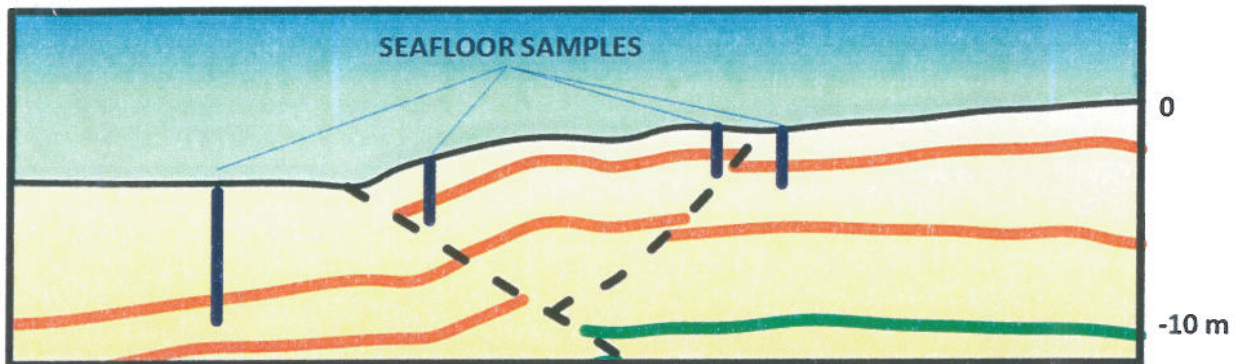


Figure 1. Schematic of seafloor sampling targets.

### 4. Process recovered sediment samples

Following the collection of seafloor sediment samples, the organic material will be selected for age dating by radiocarbon techniques.

#### Prerequisites

- California State Lands Commission Geophysical and Geological Permit must be secured.
- Results of the 2D and 3D shallow surveys must be available to determine targets.
- *R/V Melville* (or similar vessel) must be available.

#### Project Risks with Mitigation Plans

- Retrieved samples may not contain suitable organic material to perform age dating. Mitigation: Replicate cores will be obtained at target sites to minimize this risk.
- Seafloor sampling is not conducted due to weather. Mitigation: Perform survey at another time.

#### Specific Deliverable

- Dataset of age dates and sediment composition.



### **Objective**

Obtain recent onshore and offshore United States Geological Survey (USGS) geophysical surveys to update the San Onofre Nuclear Generating Station (SONGS) seismic database.

### **Scope of Work<sup>1</sup>**

The USGS has completed their onshore and offshore surveys in the region and the data are publicly available. The shallow water bathymetry data collected as part of the *California Coastal and Marine Mapping Initiative* as well as 2D shallow seismic data across the Newport Inglewood/Rose Canyon (NI/RC) and Oceanside Blind Thrust<sup>2</sup> (OBT) faults will be acquired.

### **Project Risks with Mitigation Plan**

None.

### **Specific Deliverables**

- USGS digital bathymetry data.
- USGS raw and digital 2D shallow seismic data.

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<sup>1</sup> A.11-04-006, USGS Source Fault Studies.

<sup>2</sup> The existence of the OBT Fault is unknown and further research is required.

## Objective

Install and maintain permanent onshore seismographs near the San Onofre Nuclear Generating Station (SONGS) and install and maintain temporary ocean bottom seismometers (OBS) offshore SONGS for a three year period.

## Scope of Work

This project<sup>1</sup> includes the following activities:

1. Obtain necessary permits and lease agreements for both permanent onshore seismograph installation and temporary offshore OBS installations.
2. Install and maintain permanent onshore seismograph stations and single station sigma seismograph.
3. Install and maintain temporary offshore OBS.
4. Update the Southern California earthquake catalogs.

### 1. Obtain necessary lease agreements and permits

The following lease agreements and permits will be secured:

- Lease agreements with Camp Pendleton for onshore stations.
- Army Corps federal permit for offshore stations.
- Consistency review by the California Coastal Commission (CCC) required under the Coastal Zone Management Act (CZMA).

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<sup>1</sup> A.11-04-006, Seismic Monitoring.





#### 4. Update earthquake catalog

The resultant data from the onshore network stations will be telemetered real time to the California Institute of Technology and the offshore campaign<sup>2</sup> OBS will be waveform archived and cataloged by Scripps on an annual basis. Such information will improve the earthquake catalog in and around SONGS (see Figure 2).

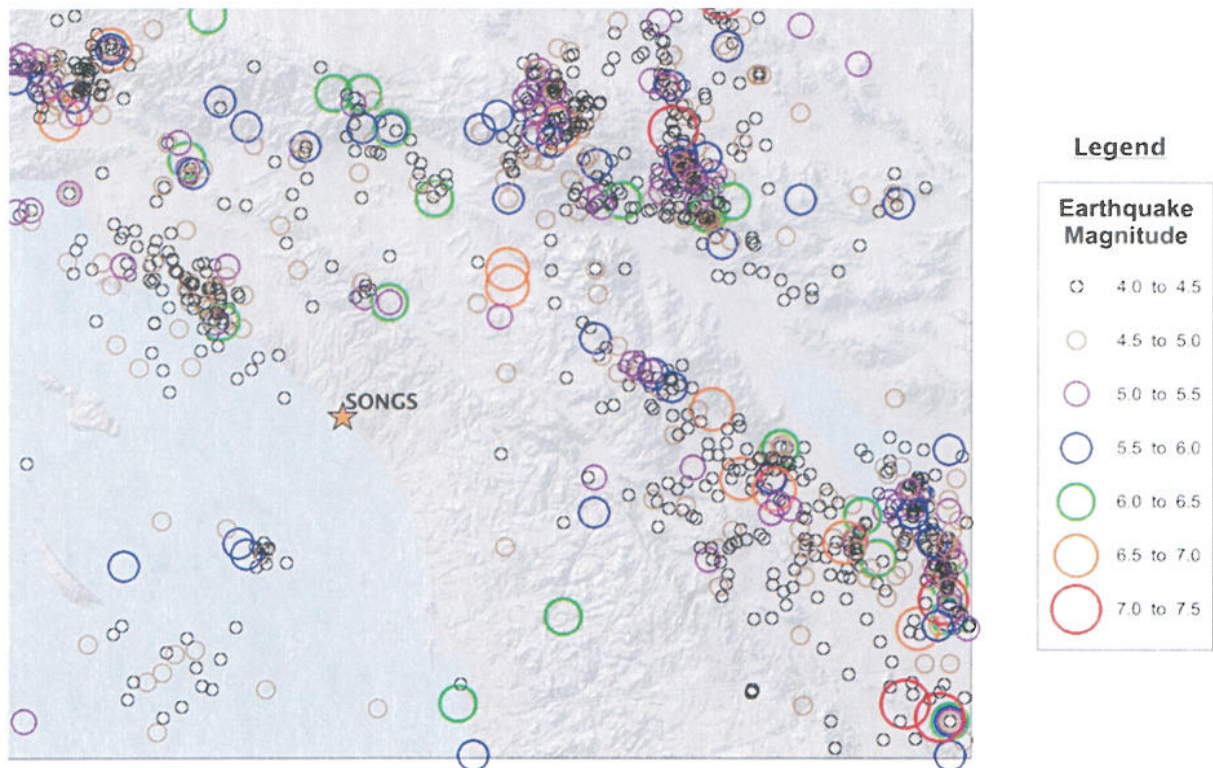


Figure 2. Historical earthquake catalog (1850 to 2006).

#### **Determination of Study Target Area**

The onshore and offshore target areas were selected to infill large instrument gaps in the larger California Integrated Seismic Network (CISN), shown in Figure 1.

#### **Prerequisites**

- Required permits, stated above, must be secured.
- Site locations for onshore stations must be secured on Camp Pendleton and private/residential properties.

<sup>2</sup> Campaign denotes multiple recoveries and redeployments.



### **Project Risks with Mitigation Plans**

- Lease agreements may not be secured to install onshore instruments. Mitigation: Other locations for onshore stations will be pursued.
- Permits for offshore stations may not be secured. Mitigation: OBS instruments will not be deployed.

### **Specific Deliverables**

- Onshore data telemetered to the Southern California Earthquake Data Center (SCEDC), California Institute of Technology, to update the earthquake catalog.
- Raw and processed offshore data archived by Scripps and made publicly available.

Seismic Research Projects  
Acronyms List (Revised 8/31/12)

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ANSS	Advanced National Seismic System
BA	Biological Assessment
CCC	California Coastal Commission
CEQA	California Environmental Policy Act
CISN	California Integrated Seismic Network
CMP	Common Mid-Point
CRADA	Cooperative Research and Development Agreement
CSLC	California State Lands Commission
CZMA	Coastal Zone Management Act
EA	Environmental Assessment
EIR	Environmental Impact Report
ESA	Endangered Species Act
GPS	Global Positioning System
IHA	Incidental Harassment Authorization
LDEO	Lamont-Doherty Earth Observatory
MCS	Multi-Channel Seismic
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NGS	National Geodetic Survey
NI/RC	Newport-Inglewood/Rose Canyon Fault
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
NSF	National Science Foundation
OBISP	Ocean Bottom Seismograph Instrument Pool
OBS	Ocean Bottom Seismometers
OBT	Oceanside Blind Thrust
OCS	Outer Continental Shelf
PEER	Pacific Earthquake Engineering Research
PV/CB	Palo Verdes/Coronado Banks
QA/QC	Quality Assurance/Quality Control
SCE	Southern California Edison
SCEC	Southern California Earthquake Center
SCEDC	Southern California Earthquake Data Center
SCIGN	Southern California Integrated GPS Network
SIOSEIS	Scripps Institute of Oceanography - Marine Seismic Processing System
SONGS	San Onofre Nuclear Generating Station
SSHAC	Senior Seismic Hazard Analysis Committee
UCERF	Uniform California Earthquake Rupture Forecast
UCSB	University of California, Santa Barbara
UCSD	University of California, San Diego
UNR	University of Nevada, Reno
USGS	United States Geological Survey
UTIG	University of Texas Institute of Geophysics